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INSTRUCTIONS FOR

AC ELECTRONIC VOLTMETER

MODEL 300

Serial # 1578D

BALLANTINE LABORATORIES, INC.
BOONTON, NEW JERSEY

Property of Test Set Maintenance

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SPECIFICATIONS

BALLANTINE MODEL 300
ELECTRONIC AC VOLTMETER

Frequency Range

10—150,000 c.p.s.

Voltage Range

1 millivolt to 100 volts rms in 5 decade ranges
(.01, .1, 1, 10 and 100 volts full scale)

Accuracy

2% up to 100 KC; 3% above 100 KC

Input Impedance

500,000 ohms shunted by a capacity of 30 mmfds.

Stability

Changes with variation in power supply voltage from 110 to 120 volts about 1%; effect of change in tubes less than ½%.

Scales

Logarithmic voltage scale reading from 1 to 10; auxiliary scale in decibels from 0 to 20. Each meter is hand calibrated.

Tubes

One 6J7, two 6SJ7, one 6H6, one 6X5 and two 991.
All tubes are supplied.

Amplifier Characteristics

Maximum voltage gain of 70 DB; maximum output voltage is 30, output impedance is 15,000 ohms at maximum gain.
Flat within 1 DB.

Power Supply

110-120 volts, 50-60 cycles. 30 watts.

Dimensions

4½" high, 5¾" wide, 11" long

Weight

9½ pounds

INSTRUCTIONS FOR
AC ELECTRONIC VOLTMETER
MODEL 300

GENERAL — This voltmeter is designed to measure sinusoidal voltages from 1 millivolt to 100 volts over a frequency range from 10 to 150,000 c.p.s. It operates from a 110-120 volt 60-cycle power supply. 220-volt models are also available on special order.

By means of a five decade range switch, the entire voltage range is indicated on a single logarithmic voltage scale reading from 1 to 10. The indicating meter also has a uniform decibel scale, numbered from 0 to 20 decibels. The zero of the decibel scale is arbitrarily arranged for maximum usefulness so as to correspond to 1 on the voltage scale.

Its accuracy is 2% up to 100,000 c.p.s. and 3% above 100,000 c.p.s. Since the scale is logarithmic the accuracy is the same at any point on the scale.

An AC output jack permits the amplifier section of the voltmeter to be used as a flat high gain amplifier with an adjustable gain from 0 to 70 DB.

GENERAL CIRCUIT DESCRIPTION — The voltmeter employs a resistance-capacity decade attenuator, a high-gain three stage negative feedback stabilized amplifier, a rectifier and a logarithmic indicating meter responding to the average values of the voltage wave but calibrated in rms values of a sine wave. The amplifier has sufficient feedback to render the indications of the voltmeter substantially independent of changes in line voltage, tubes, and other circuit components.

OPERATION — The voltmeter is supplied with tubes and is ready to operate as received. It is merely necessary to connect it to the a-c power source and turn on the switch marked "ON-OFF." A pilot light is provided to indicate when power is on. The input terminal marked GND is connected to the case of the instrument and therefore, whenever possible, it should be connected to the ground of the circuit in which a voltage is being measured.

The failure of the pilot light to light after the switch is turned on is an indication of either a blown fuse or a burned-out pilot light. The pilot light may be replaced from the front of the panel by merely unscrewing the red jewel. A three-quarter ampere fuse is mounted on the chassis inside the case. To renew the fuse first disconnect the instrument from the a-c power line and after removing the four nickel-plated screws on the panel carefully lift out the panel from the case. Care should be taken not to disturb any of the wires on the chassis.

Spare fuses are provided and if additional fuses are required these may be ordered directly from Littelfuse, Inc., 4757 Ravenswood Avenue, Chicago, Illinois. The type number is 8AG, three-quarter ampere.

INPUT IMPEDANCE — The input impedance of the voltmeter is 500,000 ohms shunted by an effective capacity of 30 mmfds.

If a higher input impedance is desired and if it is not necessary to read less than 10 millivolts, the input impedance may be increased to 5 megohms shunted by 8 mmfds. by using the Ballantine Model 1300A Multiplier ahead of the voltmeter. If it is not necessary to read less than 100 millivolts, the input impedance may be increased to 40 megohms shunted by 3 mmfds. by using the Ballantine Model 1300B Multiplier ahead of the voltmeter.

Any direct current component of the wave under measurement is kept out of the voltmeter by means of a series blocking condenser in the input circuit of 400 volts rating. If DC voltages higher than this are applied an auxiliary protective network should be provided. This may consist of an 0.2 mfd. condenser in series and a 1 megohm resistor in shunt. An example of the use of such a network would be the measurement of commutator ripple on a 600-volt dynamotor.

OVERLOAD CHARACTERISTICS — The amplifier circuits are designed to saturate promptly when the voltage exceeds the full scale indication of the meter, thus protecting the indicating meter. This is a considerable advantage over other types of meters which may be seriously damaged by overloads such as the Model 300 Voltmeter will stand. The maximum voltage which can be safely recommended on each range are as follows:

Range	Max. Voltage	Overload Ratio
.001 - .01	2	200
.01 - .1	20	200
.1 - 1	200	200
1 - 10	400	40
10 - 100	400	4

EFFECT OF WAVE FORM—The indications of the voltmeter are proportional to the average value of the a-c wave under measurement. Since, however, it is primarily intended to measure sinusoidal waves its calibration is in terms of the rms value of a sinusoidal wave. Since electronic voltmeters of the diode rectifier type respond to the peak values of a wave, the readings of such meters and the present voltmeter will not necessarily agree when harmonics are present. The amount of the discrepancy will depend on the number and magnitude of the harmonics present as well as their phase relationship with respect to the fundamental. In all cases however, the departure of the readings from true rms values due to the presence of harmonics will be considerably less with an average responding meter such as the Model 300 than with a peak responding meter. For example in the case of a third harmonic whose amplitude is 20% of the fundamental the maximum error of a peak responding meter may be as much as 20% whereas the maximum error of an average responding meter such as the Model 300 will never exceed 6.7%.

Inasmuch as the Model 300 Voltmeter responds to the average value of the a-c wave, "turn-over" discrepancies occasioned by any lack of symmetry of the wave such as are experienced in half-wave peak reading instruments are eliminated.

MEASUREMENT OF 60-CYCLE VOLTAGES—Even though the amount of residual hum in the voltmeter is extremely small, it may introduce slight inaccuracies (1 to 2%) in the readings when the voltmeter is used to measure voltages of 60 cycles derived from the same power source as that used to operate the voltmeter. These inaccuracies may be eliminated by making two measurements, one with the power plug in normal polarity and the other with the power plug reversed. The average of these readings will represent the true value of the voltage being measured.

RANGE ADJUSTMENT—This is a screw-driver adjustment to be made through a hole in the side of the case. Its purpose is to

bring the 10 on one range to exactly 1 on the next higher range. This is accomplished by means of an auxiliary voltage which compensates for the initial electron velocities in the diode. Ordinarily no adjustment should be necessary but if some discrepancy is noted the adjustment should be made as follows: Allow the meter to warm up for five minutes. Connect a source of **pure** sinusoidal a-c of any convenient frequency from 100 to 10,000 c.p.s. to the input. Adjust this voltage so that the meter reads 10 on any range other than the 100 volt range. Switch to the next higher range. The meter should read 1. If not remove the black button at the side of the case and adjust with a screw-driver until the meter reads 1. Switch back to the lower range and check to see that it reads 10. If not readjust the input voltage to 10 and switch back to 1, readjusting with the screw-driver if necessary.

In the past some users of this instrument have misunderstood the purpose of this adjustment and have tried to use it to bring the needle on the meter to 1 on the scale with no voltage applied to the input terminals. The indicating meter, being logarithmic, has no "zero." The normal position of the needle with no voltage connected to the input is against the left-hand stop and off scale. The meter should read only when a voltage within the range of the voltmeter is applied to its input terminals.

USE AS AN AMPLIFIER — Plugging into the AC output jack automatically disconnects the rectifier and the indicating meter and permits the amplifier section of the voltmeter to be used as a stable amplifier with a maximum gain of 70 DB. The gain is adjustable in steps of 20 DB by means of the range switch and finer adjustments in gain may be made by means of the knob marked "AC Output Control." When the latter is set for maximum gain the output impedance of the amplifier is approximately 15,000 ohms. The amplifier will provide uniform voltage amplification within 1 DB over the range from 10 to 150,000 c.p.s. when it is fed into a load whose resistance is not less than one megohm and whose capacitance is not more than 10 mmfd. Its residual AC hum is very low, amounting to only about 50 millivolts which is 55 DB down from its maximum undistorted output level of 30 volts.

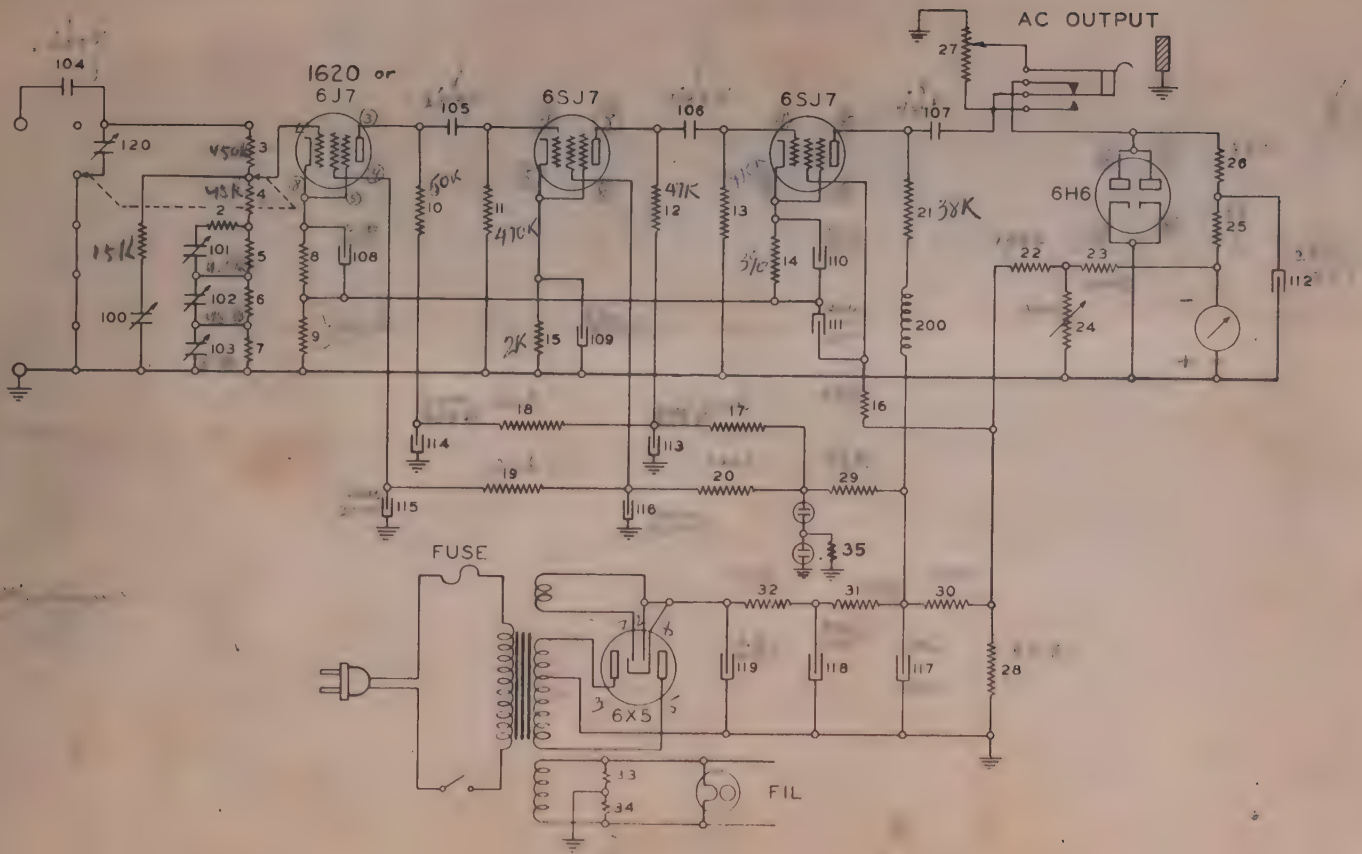
MEASUREMENT OF VOLTAGES OVER 100 VOLTS — Multipliers are available to extend the range of the voltmeter to voltages above 100. The Model 1300A Multiplier extends the range

by a factor of 10 up to 1,000 volts maximum. This has an input impedance of 5 megohms shunted by 8 mmfds. The Model 1300B Multiplier extends the range by a factor of 100 to 10,000 volts and has an input impedance of 40 megohms shunted by 3 mmfds.

MEASUREMENT OF VOLTAGES BELOW ONE MILLIVOLT—When voltages below one millivolt are to be measured in the range between 10 and 100,000 c.p.s. we recommend the use of the Ballantine Decade Amplifier. This provides gains of exactly ten times or one hundred times and when connected ahead of the Model 300 Voltmeter permits measurements down to values between 10 and 20 microvolts depending on electrical circuit noise conditions.

SERVICING— Servicing of this instrument by the user is not recommended except for the renewal of the fuse, pilot light and tubes. If trouble develops it is recommended that it be returned to us for servicing. **Before doing this the trouble should be described to us by letter,** after which shipping instructions will be furnished. The wiring in the instrument should not be tampered with because the calibration of the instrument depends critically on the position of certain wires.

MODEL 300 ELECTRONIC VOLTMETER



REFERENCE LIST OF PARTS*

Part No.		CONDENSERS	
100	-	50 mmfds. maximum,	Centralab Type 823-Z
101	-	65 to 340 mmfds.,	El-Menco No. 303
102	-	550 to 1600 mmfds.,	El-Menco No. 309; plus a 1000 mmfds. Cornell-Dubilier Type 1W Condenser in shunt
103	-	550 to 1600 mmfds.,	El-Menco No. 309; plus a .022 mfd. Sprague 67P22304, or equal, in shunt
104	-	.1 mfd., 400 volt,	Sprague Type 67P10404
105	-	.1 mfd., 200 volt,	Sprague Type 67P10402
106	-	.1 mfd., 400 volt,	Sprague Type 67P10404
107	-	.5 mfd., 400 volt,	Astron Type ML-4-5
108	-	25 mfds., 25 volt,	Sprague Type DPE
109	-	25 mfds., 25 volt,	Sprague Type DPE
110	-	25 mfds., 25 volt,	Sprague Type DPE
111	-	20 mfds., 250 volt,	Sprague Type DPE
112	-	25 mfds., 25 volt,	Sprague Type DPE
113	-	20 mfds., 250 volt,	Sprague Type DPE
114	-	20 mfds., 250 volt,	Sprague Type DPE
115	-	20 mfds., 250 volt,	Sprague Type DPE
116	-	20 mfds., 250 volt,	Sprague Type DPE
117	-	8 mfds., 450 volt,	Sprague Type DPE
118	-	8 mfds., 450 volt,	Sprague Type DPE
119	-	2 mfds., 600 volt,	Cornell-Dubilier Elec. Corp. Type T-6020
120	-	25 mmfds., maximum,	Centralab Type 823-Z

200 - 18 millihenry iron core choke, Ballantine Laboratories Type A-296A

TUBES - One Type 1620 or 6J7, RCA or equal.
Two Type 6SJ7, RCA or equal.
One Type 6H6, RCA or equal.
One Type 6X5, RCA or equal.
Two neon lamps, type 991, RCA or equal.
One pilot light, 6.3 volt, .150 amp., bayonet.

METER - Special type obtained from Ballantine Laboratories only.

FUSE - 3/4 ampere, type 8-AG, Littelfuse Inc., or equal.

TRANSFORMER - Type A-326E, Ballantine Laboratories, Inc.

* See attached wiring diagram 2/15/51

REFERENCE LIST OF PARTS*

Part No.	RESISTORS			
1	15,000 ohms,	Type EB,	5%,	Allen-Bradley Company
2	39,000 ohms,	Type EB,	5%,	Allen-Bradley Company
3	450,000 ohms,	Type 172-BX,	½%,	Shallcross Manufacturing Company
4	45,000 ohms,	Type 172-BX,	½%,	Shallcross Manufacturing Company
5	4,500 ohms,	Type 172-BX,	½%,	Shallcross Manufacturing Company
6	450 ohms,	Type 172-BX,	½%,	Shallcross Manufacturing Company
7	50 ohms,	Type 7525,	½%,	Shallcross Manufacturing Company
8	2,000 ohms,	Type EB,	5%,	Allen-Bradley Company
9	3.9 ohms,	Special,		Ballantine Laboratories, Inc.
10	50,000 ohms,	Type 180,	1%,	Shallcross Manufacturing Company
11	470,000 ohms,	Type EB,	5%,	Allen-Bradley Company
12	47,000 ohms,	Type EB,	5%,	Allen-Bradley Company
13	470,000 ohms,	Type EB,	5%,	Allen-Bradley Company
14	390 ohms,	Type EB,	5%,	Allen-Bradley Company
15	2,000 ohms,	Type EB,	5%,	Allen-Bradley Company
16	47,000 ohms,	Type EB,	5%,	Allen-Bradley Company
17	20,000 ohms,	Type EB,	5%,	Allen-Bradley Company
18	20,000 ohms,	Type EB,	5%,	Allen-Bradley Company
19	20,000 ohms,	Type EB,	5%,	Allen-Bradley Company
20	100,000 ohms,	Type EB,	5%,	Allen-Bradley Company
21	38,000 ohms,	Type 188-BX,	1%,	Shallcross Manufacturing Company
22	1 megohm,	Type EB,	5%,	Allen-Bradley Company
23	100,000 ohms,	Type EB,	5%,	Allen-Bradley Company
24	20,000 ohms,	Type Q Volume	Control,	International Resistance Co.
25	1,000 ohms,	Type EB,	5%,	Allen-Bradley Company
26	50,000 ohms,	Type 180-BX,	1%,	Shallcross Manufacturing Company
27	20,000 ohms,	Type Q Volume	Control,	International Resistance Co.
28	62,000 ohms,	Type GB,	5%,	Allen-Bradley Company
29	30,000 ohms,	Type GB,	5%,	Allen-Bradley Company
30	20,000 ohms,	Type GB,	5%,	Allen-Bradley Company
31	4,800 ohms,	Type X-2,	5%,	Continental Carbon Company
32	4,800 ohms,	Type X-2,	5%,	Continental Carbon Company
35	470,000 ohms,	Type EB,	10%,	Allen-Bradley Company

* See attached wiring diagram.

2/15/51

REFERENCE LIST OF PARTS *

Part No.	RESISTORS
1 -	51,000 ohms, Type EB, 5%, Allen-Bradley Company
2 -	390 ohms, Type EB, 5%, Allen-Bradley Company
3 -	450,000 ohms, Type 172-BX, ½%, Shallcross Manufacturing Company
4 -	45,000 ohms, Type 172-BX, ½%, Shallcross Manufacturing Company
5 -	4,500 ohms, Type 172-BX, ½%, Shallcross Manufacturing Company
6 -	450 ohms, Type 172-BX, ½%, Shallcross Manufacturing Company
7 -	,50 ohms, Type 7525, ½%, Shallcross Manufacturing Company
8 -	2,000 ohms, Type EB, 5%, Allen-Bradley Company
9 -	3.9 ohms, Special, Ballantine Laboratories, Inc.
10 -	50,000 ohms, Type 180, 1%, Shallcross Manufacturing Company
11 -	360,000 ohms, Type EB, 5%, Allen-Bradley Company
12 -	47,000 ohms, Type EB, 5%, Allen-Bradley Company
13 -	470,000 ohms, Type EB, 5%, Allen-Bradley Company
14 -	390 ohms, Type EB, 5%, Allen-Bradley Company
15 -	2,000 ohms, Type EB, 5%, Allen-Bradley Company
16 -	47,000 ohms, Type EB, 5%, Allen-Bradley Company
17 -	20,000 ohms, Type EB, 5%, Allen-Bradley Company
18 -	20,000 ohms, Type EB, 5%, Allen-Bradley Company
19 -	20,000 ohms, Type EB, 5%, Allen-Bradley Company
20 -	100,000 ohms, Type EB, 5%, Allen-Bradley Company
21 -	38,000 ohms, Type 188-BX, 1%, Shallcross Manufacturing Company
22 -	1 megohm, Type EB, 5%, Allen-Bradley Company
23 -	100,000 ohms, Type EB, 5%, Allen-Bradley Company
24 -	20,000 ohms, Type Q Volume Control, International Resistance Co.
25 -	1,000 ohms, Type EB, 5%, Allen-Bradley Company
26 -	50,000 ohms, Type 180-BX, 1%, Shallcross Manufacturing Company
27 -	20,000 ohms, Type Q Volume Control, International Resistance Co.
28 -	62,000 ohms, Type GB, 5%, Allen-Bradley Company
29 -	30,000 ohms, Type GB, 5%, Allen-Bradley Company
30 -	20,000 ohms, Type GB, 5%, Allen-Bradley Company
31 -	4,800 ohms, Type X2, 5%, Continental Carbon Co., or 4,700 ohms, Type BW-2, 5%, International Resistance Co.
32 -	4,800 ohms, Type X2, 5%, Continental Carbon Co., or 4,700 ohms, Type BW-2, 5%, International Resistance Co.
33 -	3 megohms, Type EB, 10%, Allen-Bradley Company
35 -	470,000 ohms, Type EB, 10%, Allen-Bradley Company

* See attached Wiring Diagram.

6/1/52
NEW ATT.

REFERENCE LIST OF PARTS *

Part No.		CONDENSERS	
100	-	50 mmfds. maximum,	Centralab Type 823Z or 822AN
101	-	65 to 340 mmfds.,	El-Menco No. 303
102	-	550 to 1600 mmfds.,	El-Menco No. 309; plus a 1000 mmfds. Cornell-Dubilier Type 1W condenser in shunt
103	-	550 to 1600 mmfds.,	El-Menco No. 309; plus a Sprague 67P10304 and a Cornell-Dubilier 1W in shunt
104	-	.1 mfd., 400 volt,	Sprague Type 67P10494
105	-	.1 mfd., 200 volt,	Sprague Type 67P10492
106	-	.1 mfd., 400 volt,	Sprague Type 67P10494
107	-	.5 mfd., 400 volt,	Astron Type ML-4-5
108	-	25 mfds., 25 volt,	Sprague Type DPE
109	-	25 mfds., 25 volt,	Sprague Type DPE
110	-	25 mfds., 25 volt,	Sprague Type DPE
111	-	20 mfds., 250 volt,	Sprague Type DPE
112	-	25 mfds., 25 volt,	Sprague Type DPE
113	-	20 mfds., 250 volt,	Sprague Type DPE
114	-	20 mfds., 250 volt,	Sprague Type DPE
115	-	20 mfds., 250 volt,	Sprague Type DPE
116	-	20 mfds., 250 volt,	Sprague Type DPE
117	-	8 mfds., 450 volt,	Sprague Type DPE
118	-	8 mfds., 450 volt,	Sprague Type DPE
119	-	2 mfds., 600 volt,	Cornell-Dubilier Elec. Corp. Type T-6020
120	-	25 mmfds., maximum,	Centralab Type 823-Z
121	-	100 to 550 mmfds.,	El-Menco Type 304
122	-	4.7 mmfds.,	Stackpole Type GA-6

200 - 35 millihenry, max., iron core choke, Ballantine Laboratories, Inc.

TUBES - One Type 6J7 or 1620, RCA or equal
Two Type 6SJ7, RCA or equal
One Type 6H6, RCA or equal
One Type 6X5, RCA or equal
Two neon lamps, type 991, RCA or equal
One pilot light, 6.3 volt, .150 amp., bayonet

METER - Special type obtained from Ballantine Laboratories only

FUSE - 3/4 ampere, type 8-AG, Littelfuse Inc., or equal

TRANSFORMER - Type A-326F, Ballantine Laboratories, Inc.

* See attached wiring diagram.

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